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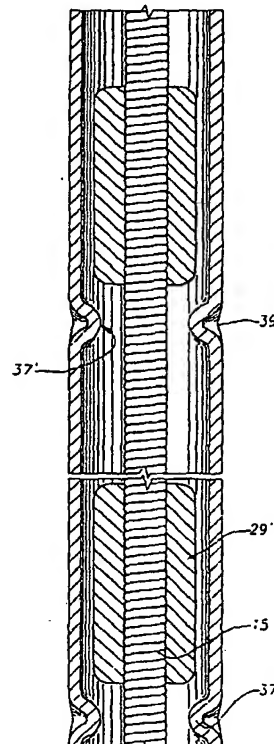
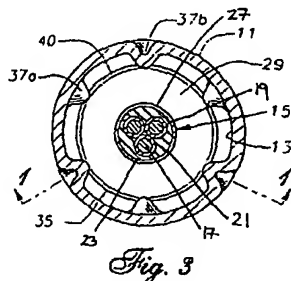
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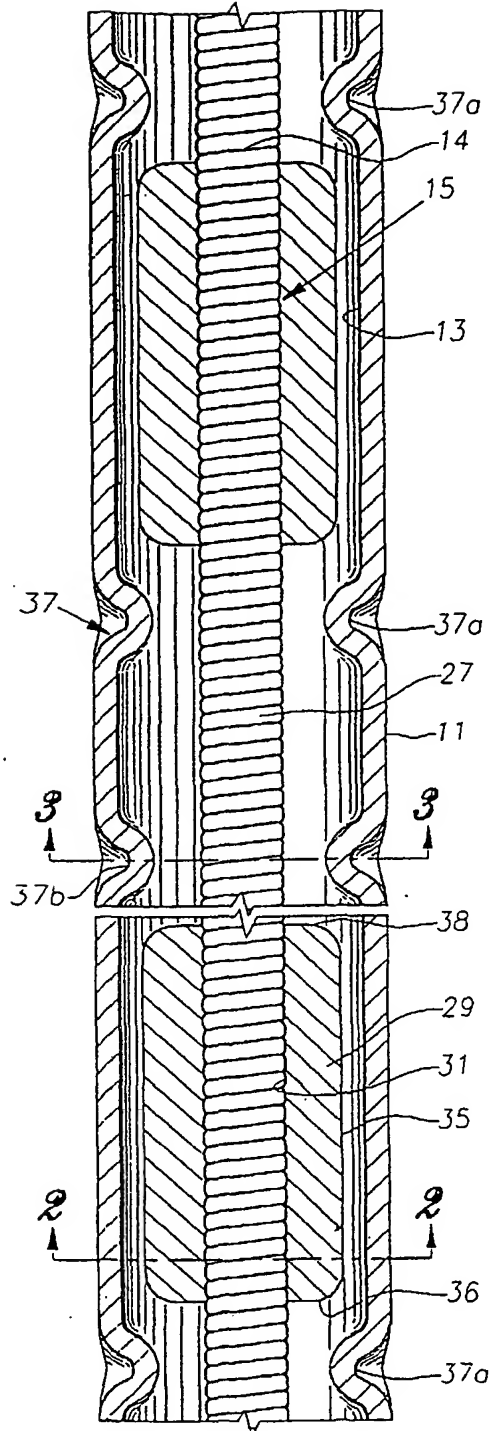
(54) Abstract Title

Coiled well tubing with indentations

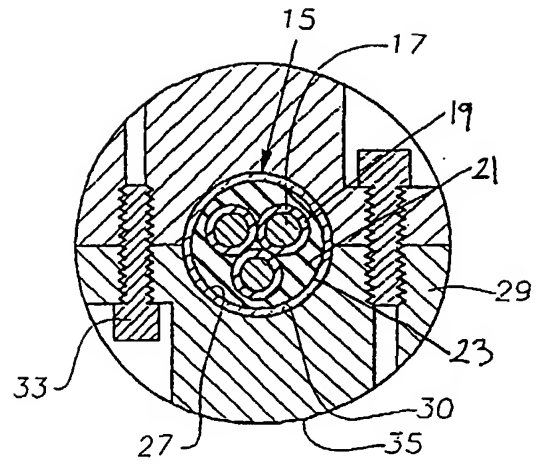
(57) A length of coiled tubing 11 for supporting an electrical cable 15 in a well as disclosed in parent application GB 2326536 A, the invention being directed to the feature of the at least one indentation, eg dimples 37', being filled with an inlay of rigid material 39 to prevent the interior surface of the indentation flattening while running the tubing in and out of the well.



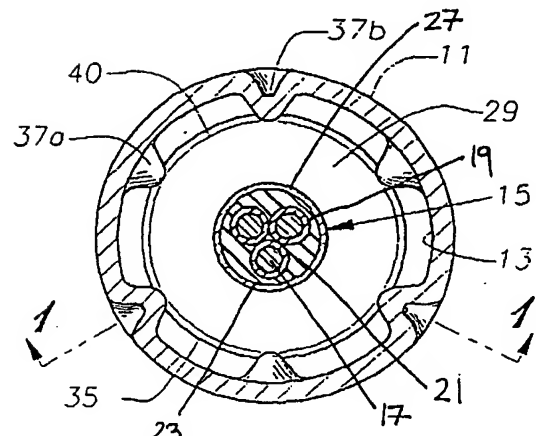
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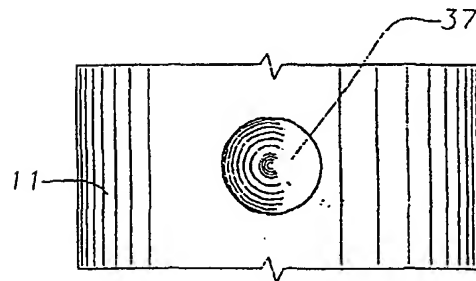
*Fig. 1*



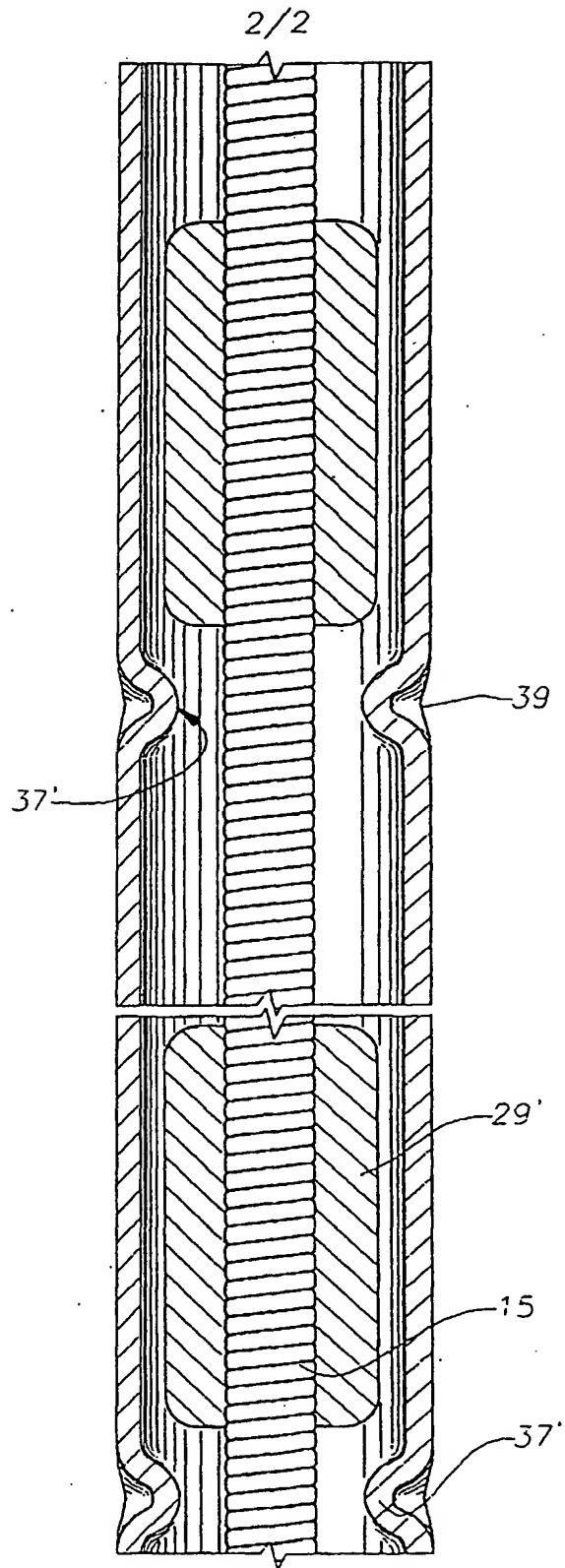
*Fig. 2*



*Fig. 3*



*Fig. 4*



*Fig. 5*

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3  
4 COILED TUBING SUPPORTED ELECTRICAL CABLE  
5 HAVING INDENTATIONS  
6  
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11  
12 This invention relates in general to power cable for  
13 electrical submersible well pumps and in particular to an  
14 electrical cable installed within a string of coiled  
15 metal tubing.  
16

17  
18 Conventional electrical submersible well pumps for  
19 oil and deep water wells are supported on a string of  
20 production tubing. The production tubing comprises  
21 sections of steel pipe screwed together, each section  
22 being about thirty feet (9.1 m) in length. The pump is a  
23 centrifugal pump driven by an AC motor located below the  
24 pump. A power cable extends from the surface alongside  
25 the tubing for supplying power to the motor. The power  
26 cable is strapped to the tubing at frequent intervals to  
27 support the weight of the power cable.

1           One disadvantage of the conventional pump assembly  
2           described above is that when the pump must be pulled for  
3           repair or replacement, the procedure is expensive. The  
4           operator needs a workover rig with the capability of  
5           pulling the sections of tubing. Pumps of this nature  
6           must be pulled typically at least every eighteen months.  
7           Considering the cost of the workover rig as well as the  
8           down time for the well, the periodic expense is  
9           significant.

10           A few installations have been made employing coiled  
11           tubing. Coiled tubing is a continuous string of metal  
12           tubing which is brought to the well site on a large reel.  
13           The coiled tubing unit unreels the tubing and forces it  
14           into the well. Coiled tubing has been used for various  
15           purposes in the past, and recently used to suspend  
16           electrical submersible pumps. An advantage of a coiled  
17           tubing supported pump is that it does not need a workover  
18           rig to pull it. Also, pulling and replacing it should be  
19           faster than production tubing.

20           One proposal in the past was to produce production  
21           fluid from the pump through the coiled tubing and strap  
22           the cable to the exterior of the coiled tubing. A  
23           disadvantage of this assembly is that a separate reel is

1 needed for the power cable. Securing the straps would  
2 slow down the installation and pulling procedure.  
3 Furthermore, commercially available coiled tubing is not  
4 large enough in diameter for desired production in many  
5 cases.

6 Some installations have been made with the  
7 electrical cable installed within the coiled tubing.  
8 Production fluid from the pump flows through a casing  
9 surrounding the coiled tubing. The electrical cable is a  
10 three-phase cable having fairly large metal conductors.  
11 The weight of the cable is such that it will not support  
12 itself in a deep well. Even if inserted within coiled  
13 tubing, the weight of the electrical cable needs to be  
14 supported by the coiled tubing. In one type of  
15 installation, separate mechanical anchors are spaced  
16 along the length of the insulated electrical cable. The  
17 cable is inserted into the coiled tubing with the anchors  
18 retracted. The anchors are then shifted to a weight  
19 supporting position, gripping the inner diameter of the  
20 coiled tubing. U.S. Patent 5,435,351, Head, July 25,  
21 1995, describes such a system.

22 Another proposal shown in U.S. Patent 5,191,173,  
23 Sizer et al, March 2, 1993, describes using an

1 elastomeric jacket of a type that will swell when exposed  
2 to a hydrocarbon liquid. The jacket is extruded over the  
3 insulated conductors during manufacturing. The jacketed  
4 electrical cable is then inserted into the coiled tubing.  
5 Then liquid hydrocarbon is pumped into the annular space  
6 surrounding the jacket, causing it to swell to  
7 frictionally grip the coiled tubing. In another  
8 embodiment, metal sleeves are bonded to the cable. After  
9 installation, the coiled tubing and sleeves are crimped  
10 to each other.

11  
12  
13 The coiled tubing of this invention has indentations  
14 formed in the sidewall to create ledges for supporting  
15 elements within such as an electrical cable. In the case  
16 of electrical cable, it is supported within the coiled  
17 tubing by retainers on the cable which are supported on  
18 indentations in the coiled tubing. The retainers are  
19 secured to the exterior of the electrical cable at  
20 various points. The retainers have an outer diameter  
21 that is less than the inner diameter of the coiled tubing  
22 to allow the electrical cable to be inserted into the  
23 coiled tubing. Subsequently, the retainers are located

1 and an indentations are placed in the coiled tubing next  
2 to the retainer.

3 Each indentation is a dimple which protrudes inward  
4 sufficiently to create a ledge which interferes with  
5 movement of the retainer. This causes the retainer to  
6 rest on the ledge, transferring load of the cable weight  
7 to the coiled tubing. Preferably, a first set of at  
8 least three indentations are spaced just below each of  
9 the retainers. A second set is positioned a short  
10 distance below the first set. The second set provides  
11 support in the event the first set allows slippage after  
12 several trips of the cable in and out of the well. Also,  
13 preferably, the outside of each of the dimples is filled  
14 with weld material to reduce the tendency for the coiled  
15 tubing injector from flattening the dimples.

16 Various embodiments of the present invention will now  
17 be described, by way of example only, and with reference to  
18 the accompanying drawings in which:

19 Figure 1 is a partial sectional view taking along line  
20 1-1 of Figure 3 and illustrating an electrical cable and  
21 coiled tubing assembly constructed in accordance with an  
22 embodiment of the present invention.

23 Figure 2 is a sectional view of the assembly of Figure  
1, taken along the line of 2-2 of Figure 1.



Figure 3 is a sectional view of the assembly of Figure 1, taken along the line of 3-3 of Figure 1.

Figure 4 is a side view of a portion of the coiled tubing of Figure 1, showing one of the dimples.

Figure 5 is a sectional view of an alternate embodiment of an electrical cable in coiled tubing.

Referring to Figure 1, the electrical power line for a submersible pump includes a string of continuous coiled tubing 11. Coiled tubing 11 is steel, has an inner diameter 13, a longitudinal axis 14 and is of conventional materials and dimensions. Coiled tubing 11 is capable of being wound on a large reel for transport to a well site, then forced into the well. An electrical cable 15 is shown inserted through the length of coiled tubing 11. Electrical cable 15 is a type particularly for supplying AC power from the surface to a downhole motor for driving a centrifugal pump (not shown) which is located at the lower end of coiled tubing 11.

As shown in Figure 3, electrical cable 15 has three conductors 17, each surrounded by an insulation layer 19. An elastomeric jacket 21 is extruded over the three

1 insulated conductors 17. Jacket 21 has a cylindrical  
2 outer diameter 23 containing a plurality of parallel  
3 longitudinal grooves (not shown). Outer diameter 23 is  
4 helically wrapped with a metal strip of armor 27 that is  
5 also of metal. In one embodiment, jacket 21 is of a  
6 material, such as Nitrile rubber, which resists swelling  
7 when exposed to hydrocarbon liquid. In this embodiment,  
8 the tightly wrapped armor 27 deforms jacket 21 and  
9 provides adequate frictional engagement between jacket 21  
10 and armor 27, preventing slippage due to the weight of  
11 power cable 15.

12 Referring to Figure 1, a plurality of retainers 29  
13 are mounted to cable 15 at selected intervals. Each  
14 retainer 29 is a metal member of at least two portions,  
15 preferably two halves. Each half has a semi-cylindrical  
16 recess 30, as shown in Figure 2. The recesses 30 mate  
17 with each other to form a circular hole with a diameter  
18 which is approximately the same as the outer diameter of  
19 armor 27. Furthermore, each recess 30 contains a  
20 plurality of helically spaced grooves 31 that form a set  
21 of threads. The pitch and configuration of grooves 31  
22 are such that they mate with the strips of helical armor

1 27. Fasteners 31 are used to secure the two halves of  
2 retainer 29 together, defining a sleeve.

3 Retainer 29 has an outer diameter 35 that is less  
4 than coiled tubing inner diameter 13. The annular  
5 clearance allows power cable 15 with its retainers 29 to  
6 be readily drawn into coiled tubing 11. In a typical  
7 instance, coiled tubing 11 will have an outer diameter of  
8 2-3/8" (0.635-0.953 cm) and a wall thickness of about 0.159"  
9 (0.404 cm). Retainer 29 will have an outer diameter 35 that  
10 is about 0.050" to 0.100" (0.127-0.254 cm) less than inner  
11 diameter 13. Each retainer 29 has a downward facing shoulder  
12 36 which is located at the lower end and is perpendicular to  
13 the longitudinal axis of tubing 11. Each retainer has an  
14 upward facing shoulder 38 which is located at the upper end  
15 and is perpendicular to the longitudinal axis 14 of tubing  
16 11. Shoulders 36, 38 are identical, allowing cable 15 to be  
17 used in an inverted manner from that shown.

18 To be able to transfer the weight of cable 15 to  
19 coiled tubing 11, a plurality of indentations or dimples  
20 37 are formed in coiled tubing 11 after power cable 15  
21 has been installed. Dimples 37 are formed by using a  
22 press or punch. Each dimple 37 is generally circular or  
23 hemispherical in configuration as shown in Figure 4,

1        having an axis perpendicular to tubing axis 14, and a  
2        diameter of about 0.5 inch (1.27 cm). Preferably, each  
3        dimple 37 will protrude inward only as far as it needs to  
4        for providing a ledge or stop to be engaged by one of the  
5        retainers 29. The amount of protrusion is typically about  
6        0.125" (0.318 cm), which provides at least an interference  
7        of 0.025" (0.064 cm) even if retainer 29 is located off to  
8        the far side of dimple 37.

9                Preferably there will be three dimples 37 within  
10       each set 37a, 37b, as shown in Figure 3. The dimples 37  
11       within each set 37a, 37b are spaced circumferentially 120  
12       degrees apart from each other in a common plane normal or  
13       perpendicular to axis 14. Each set 37a, 37b of dimples  
14       37 circumscribes a diameter 40 which is less than outer  
15       diameter 35 of retainer 29.

16               A primary set 37a of dimples 37 will be located  
17       slightly below each load shoulder 36. Optionally a  
18       primary set 37a of dimples may be located slightly above  
19       each retainer 29 so that cable 15 does not need to be  
20       oriented in up and down directions. Typically, the  
21       spacing between the primary sets 37a of dimples 37 for  
22       each retainer 29 will be one to two inches (2.5-5.1 cm)  
23       greater than the longitudinal length of retainers 29. Some

1 longitudinal movement of each retainer 29 relative to  
2 dimples 37 can thus occur when cable 15 moves from a  
3 stretched out horizontal condition during installation of  
4 cable 15 in coiled tubing 11 to a coiled condition on a  
5 reel and to a linear vertical position in a well.

6 Also, preferably a secondary set 37b is located about  
7 two inches (5.1 cm) from each primary set 37a, and spaced  
8 farther from one of the retainers 29. Dimples 37 in  
9 secondary sets 37b are the same as in primary sets 37a,  
10 however they are circumferentially staggered from dimples  
11 37 in the adjacent primary set 37a, as shown in Figure 3.  
12 Each dimple 37 in secondary set 37b is located 60 degrees  
13 circumferentially from a dimple 37 in primary set 37a.  
14 Secondary sets 37b serve as ledges in the same manner as  
15 primary sets 37a in the event that any of the primary  
16 sets 37a allows slippage to occur after several trips of  
17 tubing 11 into the well.

18 Generally, there will be a retainer 29 about every 300  
19 feet (91 m). A typical cable will provide a load on each  
20 retainer 29 of about 450 to 750 lbs (200-340 kg), which is  
21 transmitted through dimples 37 to coiled tubing 11.

22 In the method of assembly, technicians will install  
23 retainers 29 on electrical cable 15 at the selected

1 intervals. The technician secures the two halves of  
2 retainers 29 around electrical cable 15, aligning grooves  
3 31 with armor 27. Electrical cable 15 is then inserted  
4 within coiled tubing 11. This may be done in one method  
5 by pushing a stiff wire from one end of coiled tubing 11  
6 out the other. Then electrical cable 15 will be  
7 connected to the protruding end of the rigid wire, and  
8 the wire will be winched back onto a reel, drawing  
9 electrical cable 15 through coiled tubing 11. Then, the  
10 technician will locate the retainers 29 within coiled  
11 tubing 11 by ultrasonic scanning or the like. The  
12 technician then forms dimples 37 using a press or other  
13 type of deformation device.

14 Coiled tubing 11 with cable 15 installed is then  
15 wound on a reel and transported to a well. Coiled tubing  
16 11 is drawn from the reel and a submersible pump and  
17 motor (not shown) are attached to the lower end of coiled  
18 tubing 11. The lower end of electrical cable 15 is  
19 joined to a motor lead of the motor. The assembly is  
20 then inserted into the well using a conventional coiled  
21 tubing injector. As coiled tubing 11 is inserted into  
22 the well, cable 15 will move downward slightly in coiled  
23 tubing 11 due to the weight of cable 15. Lower shoulder

36 of each retainer 29 moves into supporting engagement with the lower primary set 37a of dimples 37. The lower primary set 37a of dimples 37 transfers the weight of cable 15 to coiled tubing 11. Coiled tubing 11 supports the weight of the pump and motor. Once at the proper depth, the upper end of electrical cable 15 is connected to a power supply for supplying power to the pump.

The coiled tubing 11 will be pulled from time to time for maintenance or replacement of the pump and motor. After several trips, the ledges created by the dimples 37 tend to flatten due to being squeezed by the coiled tubing injector. If slippage occurs of any of retainers 29 past primary dimple sets 37a, the slipping retainers 29 will contact and be supported by secondary dimple sets 37b.

In the alternate embodiment of Figure 5, each dimple 37' creates an exterior depression which is filled with an inlay 39 of rigid material. Preferably, inlay 39 is performed by electric welding, then the weld material is ground smooth. The welding would normally be performed immediately after dimple 37' has been made, thus after power cable 15 has been installed. Inlay 39 creates a hard inward protruding dimple 37 which resists

6  
1 deformation by the coiled tubing injector while being run  
2 in and pulled from a well. Other than inlays 39, dimples  
3 37' will be spaced and sized in the same manner as in the  
4 first embodiment. In this embodiment, however, there is  
5 no need for the secondary dimples 37a as in the first  
6 embodiment because inlay 39 resists deformation of the  
7 dimple 37. Also, as in the case of the first embodiment,  
8 it is optional whether or not to locate a dimple 37' a  
9 short distance above each retainer 29'.

10 The invention has significant advantages. The  
11 indentations and retainers provide support for the weight  
12 of the cable. The retainers are simple in construction  
13 and inexpensive, avoiding complex anchoring mechanisms  
14 that have to be internally set after the cable has been  
15 inserted into the coiled tubing. The indentations allow  
16 a number of trips into and out of the well before  
17 replacement is needed.

18 While the invention has been shown in only one of  
19 its forms, it should be apparent to those skilled in the  
20 art that it is not so limited but is susceptible to  
21 various changes without departing from the scope of the  
22 invention. For example, although the dimples of the  
23 coiled tubing are shown only for supporting the weight of



1       electrical pump power cable, they have other uses. There  
2       are many down-hole tools installed and retrieved within  
3       well tubulars that depend upon no-go stops to locate or  
4       anchor the tools within the pipe or tubing ID. In  
5       threaded pipe, short nipples with such ID profiles are  
6       made up into the pipe string as it is run into the well.  
7       With coiled tubing such short pieces can be spliced into  
8       the tubing by welding or with several types of special  
9       tubing connectors. Such splicing compromises the  
10      structural and pressure integrity of the tubing and often  
11      results in problems handling and running the coiled  
12      tubing with standard equipment. The dimples of this  
13      invention can be formed into the tubing in the field at  
14      whatever desired location and do not compromise the  
15      integrity or handling of the coiled tubing. The dimples  
16      can serve as no-go stops to locate, selectively locate or  
17      anchor down-hole tools. Such tool and dimple  
18      combinations are limited only by the imagination of the  
19      designer.  
20

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Claims

- 5     1.   An apparatus for installation in a well for  
transmitting power to a well pump, comprising:  
          a tubing having an interior passage;  
          an electrical cable having at least one insulated  
electrical conductor embedded within an elastomeric  
10    jacket, the electrical cable extending longitudinally  
through the interior passage of the tubing;  
          at least one retainer mounted to the electrical  
cable and having at least one load shoulder; and  
          at least one indentation formed in the tubing  
15    adjacent the load shoulder, the indentation protruding  
into the interior passage of the tubing and creating a  
ledge which is contacted by the load shoulder when the  
apparatus is installed in the well to transfer weight of  
the electrical cable to the tubing.  
20
2.   The apparatus according to claim 1, wherein the  
retainer comprises at least two portions which are  
clamped together around the electrical cable by  
fasteners.
- 25    3.   The apparatus according to claim 1 or 2, wherein  
the load shoulder is located on an end of the retainer.
4.   The apparatus according to claim 1, 2 or 3, wherein  
30    the indentation comprises a dimple having a dimple axis  
which is perpendicular to a longitudinal axis of the  
tubing.
5.   The apparatus according to any preceding claim,  
35    wherein the indentation has a depressed exterior surface  
which is filled with a rigid material.

6. The apparatus according to claim 5, wherein the rigid material is weld material.

7. The apparatus according to any preceding claim, wherein said at least one indentation comprises at least one set of dimples formed in the tubing adjacent the load shoulder, the dimples within the set being spaced apart circumferentially around the tubing.

8. The apparatus according to claim 7 wherein:  
each of the dimples within the set has an axis, the axes of the dimples within the set being located in a common plane which is normal to a longitudinal axis of the tubing; and  
each of the dimples has a depressed exterior surface which is filled with a rigid material.

9. The apparatus according to any of claims 1-4 or 7, wherein said at least one indentation comprises a primary set and a secondary set of dimples formed in the tubing below the load shoulder of the retainer, the dimples within each of the sets being spaced apart circumferentially around the tubing, the primary and secondary sets for the load shoulder being spaced longitudinally apart from each other.

10. The apparatus according to any preceding claim, wherein:  
the retainer has an opposite shoulder facing oppositely from the load shoulder; and wherein  
said at least one indentation comprises an additional indentation formed in the tubing adjacent the opposite shoulder.

11. An apparatus for installation in a well for transmitting power to a well pump, comprising:  
a continuous metal tubing having an inner diameter;

an electrical cable having at least one insulated electrical conductor embedded within an elastomeric jacket, the electrical cable extending longitudinally through the tubing;

5           at least one retainer mounted to the electrical cable and having an outer diameter which is less than the inner diameter of the tubing; and

          at least one primary set of dimples integrally formed in the tubing, the dimples within the primary set  
10       being spaced circumferentially apart from each other and protruding into the tubing a distance which circumscribes a clearance diameter which is less than the outer diameter of the retainer, creating ledges which are engaged by the retainer when the apparatus is  
15       installed in the well.

12. The apparatus according to claim 11, wherein there are at least three of the dimples within the primary set, each of the dimples being circular and having an  
20       axis, the axes of the dimples within the primary set being in a common plane normal to a longitudinal axis of the tubing.

13. The apparatus according to claim 11 or 12, wherein  
25       said at least one primary set of dimples comprises a pair of primary sets of the dimples, one of the primary sets being located adjacent to each end of the retainers.

30       14. The apparatus according to claim 13, wherein a longitudinal distance between the primary sets of dimples for the retainer is greater than a length of the retainer to allow limited longitudinal movement of the retainer in the tubing relative to the dimples.

35

15. The apparatus according to any of claims 11-14, wherein the retainer comprises at least two portions

which are clamped together around the electrical cable by fasteners.

5 16. The apparatus according to claim 11 or 12, wherein each of the dimples has a depressed exterior surface which is filled with a rigid material.

10 17. The apparatus according to claim 16, wherein the rigid material is weld material.

18. The apparatus according to any of claims 11-15, further comprising:

15 at least one secondary set of dimples formed in the tubing, the secondary set being spaced longitudinally a short distance from the primary set, the dimples within each of the adjacent primary and secondary sets being staggered circumferentially from each other.

20 19. A length of coiled tubing for use in a well, comprising:

at least one indentation integrally formed in the tubing, the indentation having an interior surface protruding into an interior passage of the tubing for creating a ledge; and wherein

25 the indentation creates an exterior depression which is filled with an inlay of rigid material to prevent the interior surface of the indentation from flattening while running the tubing in and out of the well.

30 20. The coiled tubing according to claim 19, wherein the indentation is a dimple having a dimple axis which is perpendicular to a longitudinal axis of the tubing.

35 21. The coiled tubing according to claim 19 or 20, wherein the rigid material is steel weld material.

22. The coiled tubing according to claim 19, 20 or 21, wherein the indentation is a circular dimple.
23. The coiled tubing according to any of claims 19-22, wherein said at least one indentation comprises a plurality of dimples spaced around a circumference of the tubing in a common plane perpendicular to an axis of the tubing.
24. The coiled tubing according to claim 23, wherein each of the dimples is circular and the rigid material is steel weld material.
25. A method of installing an electrical cable within tubing for use in a well, the electrical cable having at least one insulated electrical conductor embedded within an elastomeric jacket, comprising:
- (a) mounting at least one retainer to the electrical cable, the retainer having a load shoulder which is adapted to face downward when installed within a well;
  - (b) inserting the electrical cable into the tubing; and
  - (c) locating the retainer within the tubing and forming at least one load supporting indentation in the tubing adjacent to and spaced a short distance from the load shoulder, the load supporting indentation protruding into the tubing to create a ledge for engagement by the load shoulder when the tubing is installed within a well.
26. The method according to claim 25, wherein step (a) further comprises providing the retainer with an opposite shoulder which is adapted to face upward when installed within a well; and wherein the method further comprises:
- forming at least one indentation in the tubing

adjacent to and spaced a short distance from the opposite shoulder for engagement by the opposite shoulder.

- 5      27. A method of deploying coiled tubing in a well, comprising:
- (a) forming at least one indentation in the tubing having an interior surface which protrudes into an interior passage of the tubing for creating a ledge; and
- 10        (b) filling an exterior depression created by the indentation with an inlay of rigid material; then
- (c) running the tubing into the well.
- 15      28. The method according to claim 27, wherein step (b) comprises filling the depression with a weld material.
- 20      29. The method according to claim 27 or 28, further comprising inserting a member into the tubing and supporting the member on the ledge after step (d).
- 25      30. Apparatus for installation in a well for transmitting power to a well pump substantially as hereinbefore described with reference to the accompanying drawings.
31. A method of installing an electrical cable within tubing for use in a well substantially as hereinbefore described with reference to the accompanying drawings.

Amended claims have been filed as follows

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Claims

- 5      1.    A length of coiled tubing for use in a well,  
         comprising:  
             at least one indentation integrally formed in the  
         tubing, the indentation having an interior surface  
         protruding into an interior passage of the tubing for  
10     creating a ledge; and wherein  
             the indentation creates an exterior depression  
         which is filled with an inlay of rigid material to  
         prevent the interior surface of the indentation from  
         flattening while running the tubing in and out of the  
15     well.
2.    The coiled tubing according to claim 1, wherein the  
         indentation is a dimple having a dimple axis which is  
         perpendicular to a longitudinal axis of the tubing.
- 20     3.    The coiled tubing according to claim 1 or 2,  
         wherein the rigid material is steel weld material.
4.    The coiled tubing according to claim 1, 2 or 3,  
25     wherein the indentation is a circular dimple.
5.    The coiled tubing according to any of claims 1-4,  
         wherein said at least one indentation comprises a  
         plurality of dimples spaced around a circumference of  
30     the tubing in a common plane perpendicular to an axis of  
         the tubing.
6.    The coiled tubing according to claim 5, wherein  
         each of the dimples is circular and the rigid material  
35     is steel weld material.



7. A method of deploying coiled tubing in a well, comprising:

- (a) forming at least one indentation in the tubing having an interior surface which protrudes into an interior passage of the tubing for creating a ledge; and
- (b) filling an exterior depression created by the indentation with an inlay of rigid material; then
- (c) running the tubing into the well.

8. The method according to claim 7, wherein step (b) comprises filling the depression with a weld material.

9. The method according to claim 7 or 8, further comprising inserting a member into the tubing and supporting the member on the ledge after step (d).



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Claims searched: 1-9

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**Search Report under Section 17**

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:  
UK Cl (Ed.S): E1F (FHJ); F2P (PC3, PC9); H1A (AKR); H2C (CCH, CDA, CDB)  
Int Cl (Ed.7): E21B 17/10, 17/20, 19/22, 43/12; F16L 7/00, 9/04, 57/00; H01B 7/04;  
H02G 3/04  
Other: Online databases: EPODOC, JAPIO, WPI

**Documents considered to be relevant:**

Category	Identity of document and relevant passage	Relevant to claims
A	GB 0729695 (BICC Ltd)	
A	EP 0637115 A1 (Etablissements Courant SA)	
A	FR 2619749 A (Campagnolo SA)	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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